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Epistemology, Reasoning, and Logic

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Abstract

This feature reports on the Epistemology, Reasoning, and Logic session of the first Milan Logic and Philosophy of Science Network workshop (12th March 2025). The session brought together six contributions addressing diverse aspects of scientific reasoning: the psychology of extreme beliefs, analogical reasoning in contemporary physics, joint commitment across species, the epistemology of pseudoscience and disinformation, logical reasoning with data, and modal logic for truth-maker semantics.

Keywords

Psychology of Belief Formation; Analogical Reasoning; Joint Commitment; Epistemology of Pseudoscience; Epistemology of Disinformation; Modal Logic; Data-Driven Inference.

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The first meeting of the *Milano Logic and Philosophy of Science Network* convened scholars from the Milan area engaged in research at the crossroads of logic and philosophy of science. The meeting was hosted by Politecnico di Milano (PoliMi) on 12 March 2025. The network aims to strengthen collaboration among researchers based at institutions located in Milan, fostering exchanges across disciplinary boundaries and encouraging dialogue between formal, empirical, and conceptual approaches to scientific inquiry.

Contributions in Epistemology, Reasoning, and Logic explored the diverse ways in which reasoning processes, ranging from the psychological and social to the formal and computational, inform the production and justification of scientific knowledge.

Specifically, concerning the psychology of belief formation, Giorgia Adorno (Università Vita-Salute San Raffaele) presented her work on the psychology of extreme beliefs. Pseudoscientific theories can be understood as a distinct form of

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extreme belief: coherent yet rigid systems of thought that promise clarity in the face of uncertainty. Far from being mere products of ignorance, these beliefs fulfil profound psychological needs for meaning, stability, and control. At their core lies the interplay between two motivational forces: the need for understanding – the human drive to construct coherent explanations of reality – and the need for cognitive closure – the desire for definitive answers that resolve ambiguity and restore a sense of order. When these needs become particularly salient, they can give rise to an illusion of causality, fostering the perception of patterns and causal links where none objectively exist. In this light, pseudoscience functions as a psychological mechanism of closure: it offers immediate, emotionally satisfying explanations that reduce cognitive tension, even at the cost of accuracy. Adorno's project explores these underlying dynamics to illuminate why, for many, pseudoscientific worldviews remain not only plausible but psychologically indispensable.

Turning to the role of conceptual tools in the sciences, Antoine Brandelet (Politecnico di Milano) presented his project concerning analogical reasoning in contemporary physics. The role of analogies in physics is a long standing philosophical debate. Generally speaking, an analogical reasoning is a mapping that links two distinct domains (source and target) which are supposed to present a form of resemblance allowing us, from a series of known shared properties, to infer the existence of an additional similarity. Looking at the

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history of physics, one can find many examples of successful analogies, but while in most concrete cases a common causal structure is shown to support the similarity justifying the inference, the success of more formal analogies in theoretical physics remains mysterious. "Analogical Reasoning in Contemporary Physics" is a PRIN 2022 collaborative research project between Politecnico di Milano and Università degli Studi di Urbino Carlo Bo that aims at exploring the role of analogies in contemporary physics, particularly quantum field theories and black hole physics. It also incorporates an educational focus (in collaboration with the Effediesse Lab at PoliMi) which seeks to shed light on the contribution of analogies in science learning.

On the topic of social cognition and cooperation, John Michael (Università degli Studi di Milano) presented his work on joint commitment across species. It has been argued that the capacity to form joint commitments is crucial for stabilising joint action in humans, and may be foundational for social norms and institutions. But humans are not the only animals to engage in joint actions for which joint commitment may be important. To structure research on the phylogeny of joint commitment, we propose a behavioural definition of joint commitment which does not presuppose characteristically human forms of cognition, communication, or awareness. It is sufficiently broad to include paradigmatic cases of joint action in humans as well as cases of joint commitment in non-human animals. This will enable

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us to identify mechanisms which humans share with other animals, as well as to home in on uniquely human mechanisms, as well as differences across species.

Carlo Martini (Università Vita-Salute San Raffaele) explored the epistemology of pseudoscience and disinformation, highlighting how the two are connected in the theory and in practice. There are various rational explanations for why people believe disinformation. Among the drivers of disinformation are motivated reasoning, political polarization, cognitive biases, fake news. But can motivated reasoning, polarization, and cognitive biases really explain all or even most cases of disinformation? And are people genuinely looking for high-quality information? The focus of the presentation was on scientific disinformation. Scientific disinformation has a solid evidential basis in pseudoscience, that is, pseudoscience provides the (false) evidence that allows scientific disinformation to thrive. Debunking pseudoscience is essential, and it requires establishing criteria to identify, for example, pseudo-experts and pseudoscientists. These can be recognized by examining citations, authors' credentials, and acknowledgements in papers. The talk introduced the research project 'Demarcation for Dummies', which investigates pseudoscience and disinformation and develops strategies to counter them by promoting media, science, and health literacy through randomized online and field experiments testing cognitive, behavioural, and AI-based interventions.

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The session then turned to formal and logical methods for scientific reasoning. Hykel Hosni (Università degli Studi di Milano) presented the research activities of the Logic, Uncertainty, Computation, and Information (LUCI) Lab at the University of Milan, focusing on the Reasoning with Data (ReDa) project. The project interrogates how logic can contribute to understanding and structuring reasoning in data-intensive and AI-driven science, which is inherently stochastic. Challenging the traditional probabilistic interpretation of scientific inference, ReDa reframes the problem as one of logical validity rather than probabilistic ideology. By developing formal frameworks for data-driven inference, the group explores how logical methods can enhance the construction, evaluation, and application of scientific knowledge, from epidemiological modelling to clinical decision-making. Ongoing collaborations include projects with the Istituto Tumori of Milan and interdisciplinary teams addressing topics such as e-values, policy reasoning, and inductive inference.

Vita Saitta (Università Cattolica del Sacro Cuore) presented ongoing work by the Logic Group at the Department of Philosophy on Modal Logic for Truthmaker Semantics. This presentation introduced the research carried out by the Logic Group at the Department of Philosophy of the Università Cattolica del Sacro Cuore in Milan, featuring Vita Saitta and Alessandro Giordani. The group's work focuses on applying modal logic to truthmaker semantics, an approach grounded

in the notion of an exact truthmaker – a state that brings about the truth of a formula and is wholly relevant to it. Truthmaker semantics is emerging as a major framework in philosophical logic and the philosophy of language, offering alternatives to the traditional Possible Worlds Semantics. It reshapes the analysis of meaning, subject matter, and content in linguistic expressions, provides new semantics for non-classical logics, and offers refined accounts of conditional and counterfactual reasoning. Although its application to modal operators is still in its early stages, this line of research has already advanced the study of metaphysical and deontic modalities, shedding new light on the nature of necessity, possibility, obligation, and permission.

Together, these contributions highlighted the richness of ongoing research in the Milan area on the epistemological and logical dimensions of scientific reasoning. The session demonstrated how interdisciplinary collaboration, bridging cognitive science, formal logic, and philosophy of science, can advance our understanding of how knowledge is formed, justified, and represented.

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